



An Item-Based Analysis of PTSD Emotional Numbing Symptoms in Disaster-Exposed Children and Adolescents

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Abstract

This study was designed to investigate the roles of numbing of positive and negative emotions in PTSD symptomology and related functional impairments. 14,465 Chinese children and adolescents who personally experienced the 2008 Wenchuan earthquake (in Sichuan province, China) took part in the study. Emotional numbing and other PTSD symptoms were assessed by the University of California–Los Angeles PTSD Reaction Index for Children. Functional impairment was measured by the Pediatric Quality of Life Inventory 4.0 Generic Core Scales. Item response theory (IRT) analysis showed that both numbing of positive and negative emotions demonstrated acceptable item response characteristics; numbing of positive emotions had better discrimination. Group comparisons revealed that participants who reported numbing of both positive and negative emotions had the highest risk of developing PTSD, most severe PTSD symptoms and functional impairments, with large effect sizes when compared with participants with no emotional numbing symptoms. Reporting only numbing of positive emotions had moderate effects, and reporting only numbing of negative emotions had smaller effects. The results revealed associations between emotional numbing patterns, posttraumatic stress symptoms and impairments in quality of life, and suggests that additional research is needed to explore generalized emotional numbing in children and adolescents in future PTSD research.

Keywords Post-traumatic stress disorder · Emotional dysregulation · DSM · Natural disaster · Quality of life

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Introduction

As reported by the United Nations, children and adolescents have become the largest age group affected by various disasters worldwide (United Nations Office for Disaster Risk Reduction 2011). More than 100 million youth are affected by disasters every year. Disasters can lead to mental health problems among children and adolescents, among which posttraumatic stress disorder (PTSD) was reported to be the most common and primary disorder (Furr et al. 2010). The prevalence of experiencing PTSD symptoms in disaster-exposed children and adolescents could be up to 86% (Fairbank and Fairbank 2009). Despite a great deal of research on PTSD in disaster-exposed youth, missing from the literature is evaluation of modifications to single symptoms in PTSD diagnosis criteria.

One of the most noteworthy modifications in DSM PTSD over time is the change in the emotional numbing criterion. Emotional numbing was considered a core symptom of PTSD since the disorder was first defined in DSM-III (APA 1980). The symptom was found to have high positive predictive power in identifying individuals with PTSD compared with other symptoms (Foa et al. 1995). Studies have revealed that numbing

symptoms, especially emotional numbing, were specifically related to chronic PTSD (Marshall et al. 2006; Solberg et al. 2016), the course of total PTSD symptoms (North et al. 2004), functional impairment (Pietrzak et al. 2015), and poorer response to interventions (Kerig et al. 2012; Taylor et al. 2001) in PTSD patients. Emotional numbing was described as “restricted range of affect” from DSM-III to DSM-IV-TR, which represents a general numbing to both positive and negative emotions. However in DSM-5 (APA 2013), the description was modified to “persistent inability to experience positive emotion”, which highlighted numbing of positive emotions as a key feature of emotional numbing in PTSD. The DSM-5 PTSD working group implemented this modification based on evidence that PTSD patients reported the experience of negative emotional states but demonstrated hyporesponse to stimuli related to positive affect (Friedman 2013).

DSM-III-R suggested two contrasting definitions of emotional numbing in PTSD. Emotional numbing was broadly defined as a generalized deficit in emotional responding, but a deficit in emotional responding to only positive stimuli in a more narrow definition (Litz 1992). Numerous theories have been developed to explain emotion processing deficits in PTSD. According to Keane’s conditioning model of PTSD, emotional numbing results from avoidance of trauma-related stimuli, which reduce exposure to emotion-eliciting situations and suppresses the internal experience of emotion (Keane et al. 1985). Additionally, the information-processing model conceptualizes emotional numbing as a component of denial to minimize traumatic memory-related feelings (Horowitz 1986). From a physiological perspective, some researchers suggested that emotional numbing could be a type of stress-induced analgesic effect after uncontrollable and unpredictable trauma exposure (Foa et al. 1992). The aforementioned theories all support emotional numbing of general responsiveness. Litz’s theory, however, argues that PTSD patients have difficulty expressing only positive emotions, and responsiveness to emotional stimuli with a negative valence is enhanced in PTSD (Litz and Gray 2002). The theoretical debate on which emotions are constricted in PTSD has lasted for quite some time. Generally based on Litz’s theory, the DSM-5 adopted the narrow definition of emotional numbing, and restricted the posttraumatic numbing response only to positive emotions.

The modification to PTSD’s emotional numbing has gained some empirical support from experimental studies with adult samples (e.g. Amdur et al. 2000; Spahic-Mihajlovic et al. 2005), while several more recent studies suggest a different pattern of emotional numbing in children and adolescents exposed to traumatic events. In contrast to numbing of positive emotions, numbing of fearful emotions was reported to be specifically associated with various types of violence exposure and delinquent behaviors (Allwood et al. 2011). One study investigated relations between emotional numbing and PTSD symptoms in an adolescent sample (Kerig et al.

2016), finding that only general emotional numbing and numbing of anger accounted for significant variance in PTSD symptom severity. Path analyses revealed that only numbing of anger and general emotions, but not numbing of positive emotions, mediated the association between trauma exposure and PTSD symptoms. One question arises from these findings: whether the modification to include numbing of only positive emotions in DSM-5 accurately characterizes posttraumatic responses in children and adolescents? Given that children and adults have different PTSD presentations (Danzi and La Greca 2016), the generalizability of narrowing the definition of emotional numbing in DSM-5 should be further validated in child and adolescent samples.

Item response theory (IRT) provides a good opportunity to shed light on the relationship between different emotional numbing types and PTSD. IRT can evaluate psychometric characteristics for each single symptom by examining the relationship between the probability of endorsement of specific items and overall symptom severity, and helps identify informative symptom indicators of mental disorders. It has been pointed out that IRT models are more appropriate than traditional psychometric models to assess the performance of indicators when the purpose is to identify the presence of a symptom (Cloitre et al. 2018). Therefore, by estimating the IRT model, we are able to test the presence of numbing of positive and negative emotions in individuals who suffer from PTSD. Also, by comparing item performance metrics, we can evaluate which type of emotional numbing is more typical in PTSD.

We conducted this study in 2011 with Chinese child and adolescent earthquake survivors to investigate the roles of numbing of positive and negative emotions in PTSD symptomology. The UCLA PTSD Reaction Index (PTSD-RI) for DSM-IV (Child version) (Steinberg et al. 2004) was used to measure PTSD symptoms because it contains two items measuring numbing of positive and negative emotions, respectively. In this study, we performed IRT analysis to examine the characteristics of these two items within the numbing symptom cluster of PTSD. After this examination, we compared (1) current PTSD diagnosis status; (2) PTSD symptom severity; and (3) functional impairment between participants with four different emotional numbing patterns. Basing on existing evidence, we hypothesized that both numbing to positive and negative emotions would be associated with PTSD symptomology and functional impairment in trauma-exposed children and adolescents.

Methods

Participants

In May 2008, the Wenchuan earthquake hit Sichuan Province in China, and Beichuan County was one of the most damaged

areas from the disaster. To evaluate long-term effects of the earthquake to local child mental health, the education department of Beichuan conducted a survey of all grade 3 to grade 9 students from all primary and secondary schools in the county in 2011. The sample included 14,465 children and adolescents who personally experienced the earthquake. All participants completed self-report questionnaires in a group-administration format in classrooms after being introduced to the study's aim. Trained research assistants administered the surveys with assistance of the school teachers. Informed consent/assent was obtained from all students and their guardians. The study procedures were approved by the Ethics Review Board of the Institute of Psychology, Chinese Academy of Sciences.

In the whole sample, age was ranging from 6 to 18 years old. The mean age of the sample was 12.3 years old ($SD = 2.0$). Nearly half of the sample (49.6%) were boys, 49.7% were girls and 0.7% were missing sex information. Self-reported ethnicity included Qiang (52.6%), Han (44.7%), other Chinese ethnicities (1.6%), and 1.1% were missing ethnicity information.

Measures

Trauma exposure was measured by a previously-established questionnaire asking 5 yes or no questions about traumatic experience from the earthquake, including traumatic death of a family member, being injured, witnessing injury, witnessing buildings collapse, and exposure to a corpse. These five items were the most commonly reported in prior research within this disaster-exposed population. Item responses were summed to reflect the level of earthquake-related trauma exposure. 66.1% of the participants reported at least one of these traumatic experiences. The trauma exposure characteristics of this sample have been detailed previously (Li et al. 2019).

We assessed PTSD symptoms using the 20-item PTSD-RI (DSM-IV version), as data were collected in 2011 before DSM-5 became standard. It uses a 5-point Likert scale (from 0 = never to 4 = most of the time) to rate PTSD symptoms individuals experienced during the past month. For each item, endorsement of a score of 2 or higher indicated the presence of a clinically significant symptom (Stimmel et al. 2014). The self-report scale contains 18 items corresponding to DSM-IV PTSD symptom criteria; two additional items assessing associated features (i.e. fear of recurrence, trauma-related guilt) were excluded from analysis. The PTSD-RI includes two items to measure emotional numbing symptoms, and the item with a higher score was used to represent the severity of emotional numbing for each participant. The two items are: "I have trouble feeling happiness or love" and "I have trouble feeling sadness or anger", which reflect numbing of positive and negative emotions, respectively. The PTSD-RI demonstrates good reliability and validity (Steinberg et al. 2013), and is a frequently used scale in child and adolescent PTSD

studies. In our study, participants were instructed to rate their PTSD symptoms based on the earthquake. Cronbach's α for the total scale was 0.87 in this sample.

Functional impairment was measured by the Pediatric Quality of Life Inventory (PedsQL) 4.0 Generic Core Scales (Vami et al. 2003). It is a 23-item self-report instrument. The instrument contains subscales measuring specific functional impairments in four subdomains for children on a 5-point Likert scale from 0 (never a problem) to 4 (almost always a problem) including: physical (e.g. hurt or ache), emotional (e.g. feel sad or blue), social (e.g. trouble getting along with peers), and school functioning (e.g. trouble keeping up with school work). Subscale scores were calculated as the sum of corresponding item responses. The Chinese version of the PedsQL scale has demonstrated good reliability and validity (Li et al. 2019). In our study sample, Cronbach's α s were 0.84, 0.85, 0.74 and 0.75 for each subscale, and 0.92 for the total scale.

Data Analysis

Item Response Theory (IRT)

The two-parameter logistic IRT (2PL) model was estimated for IRT analysis (Lord and Novick 1968). Because IRT analysis is usually performed within one symptom cluster, the IRT model was estimated among all PTSD numbing symptoms (C3 to C7 symptom). The 2PL model was estimated by full information maximum likelihood estimation with robust standard errors (MLR), using Mplus 7.0 software. After adjusting for differences in underlying PTSD numbing severity, difficulty and discrimination parameters were estimated for each numbing symptom, including numbing of positive and negative emotions. The difficulty parameter of one item indicates the latent severity of numbing when the symptom has a probability of 50% of being endorsed (rated 2 or higher). Higher difficulty means the item is less likely to be reported if the underlying overall symptom level is not severe enough. The discrimination parameter of an item represents the rate of change in possibility of symptom endorsement across increasing levels of latent numbing severity. Higher discrimination reflects better capability of an item to differentiate between individuals high vs. low in numbing symptom severity. Good item performance is characterized by intermediate difficulty and higher discrimination.

Group Comparison

To investigate the relationship between emotional numbing and PTSD symptomology, the ratio of probable PTSD diagnosis, PTSD total symptom severity and functional impairment were compared among individuals with different emotional numbing patterns. The total sample was divided into four subgroups based on their condition of endorsing numbing of positive and negative emotions: no emotional numbing (NN) group, numbing of only

positive emotions (NoP) group, numbing of only negative emotions (NoN) group, and general numbing of both positive and negative emotions (NoG) group.

Chi-square tests were used to compare the ratio of probable PTSD diagnosis between the four groups by pairs. Analysis of variance (ANOVA) was conducted with SPSS 20.0 to examine between-group differences in PTSD total scores, PTSD symptom cluster scores and functional impairment. To avoid potential bias, emotional numbing items were excluded when calculating PTSD total scores and PTSD Criterion C scores. If ANOVA findings were significant at the 0.05 level, we then performed post-hoc pairwise comparisons using Games–Howell tests. Cohen's *d* was calculated as the effect size of between-group differences. Subsequently, we tested the reliability of ANOVA results by adding sex, age, ethnicity and earthquake-related trauma exposure into the model as covariates. Bonferroni corrections were used to correct for multiple comparisons in all analyses.

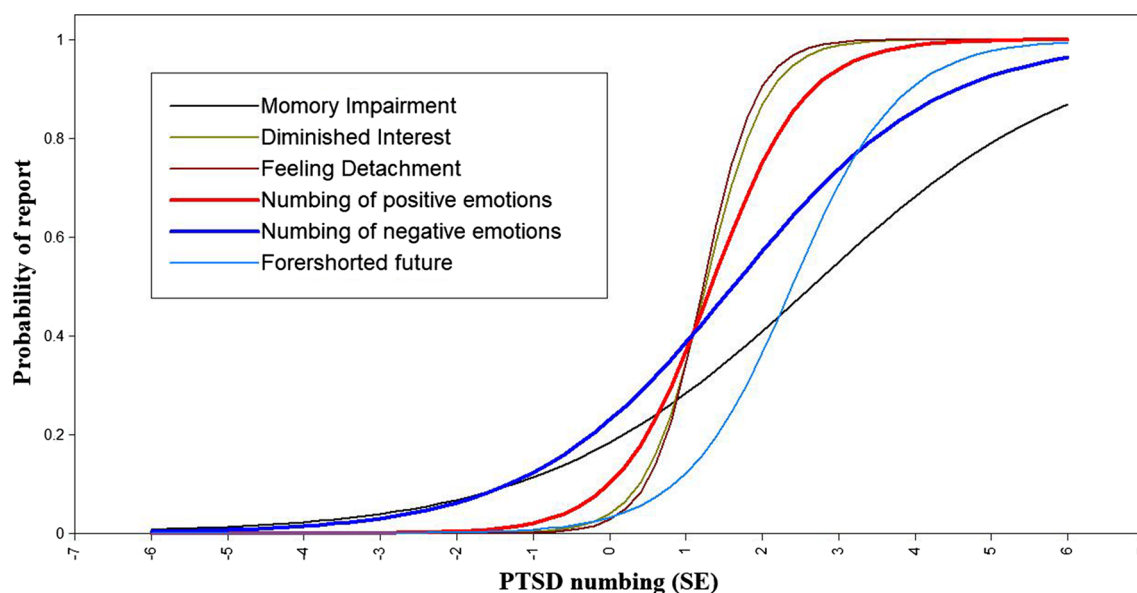
Results

Mean scores for the PTSD-RI and for functional impairment in our sample are shown in Table 3. Probable PTSD diagnosis was estimated using the DSM-IV diagnostic algorithm of at least one clinically significant re-experiencing, three significant avoidance/numbing and two significant arousal symptoms. According to the function criterion of DSM-IV's PTSD diagnosis, only these participants who showed evidence of significant functional impairment (determined by cut-off scores on the PedsQL scale, Varni et al. 2003) were considered as probable PTSD cases. In the whole

sample, 8.5% ($n = 1232$) of participants met probable PTSD diagnostic criteria. Girls reported more overall PTSD symptoms than boys ($p < 0.001$, Cohen's $d = 0.18$), and participants who self-reported as Chinese Qiang reported more overall PTSD symptoms than those who self-reported as Chinese Han ($p < 0.001$, Cohen's $d = 0.23$); however, these effects were small in magnitude. There was no significant difference in overall PTSD symptoms between different age groups ($p > 0.05$, Cohen's $d = 0.02$).

Figure 1 shows item characteristic curves (ICCs) of the PTSD numbing symptoms, which allows a direct comparison of items' performance estimates. Curves closer to the right side means higher difficulty. The steeper and taller the curve, the higher discrimination level. Table 1 shows the estimated parameters. Both 'numbing of positive emotions' and 'numbing of negative emotions' demonstrated intermediate difficulty parameters. In terms of discrimination, 'numbing of positive emotions' symptom had intermediate discrimination, and discrimination of the 'numbing of negative emotions' was relatively low, deviating from the other numbing items. Other numbing symptoms had good performance, except the 'memory impairment' symptom which demonstrated the highest level of difficulty and lowest discrimination.

For the whole sample, 64.4% participants were classified into the no emotional numbing group ($N = 9314$), 17.7% participants in the numbing of only negative emotions group ($N = 2559$), 10.4% participants in the numbing of only positive emotions group ($N = 1498$), and 7.6% participants in the general numbing of both positive and negative emotions group ($N = 1094$). Among participants who met probable PTSD diagnostic criteria, distribution of the four groups was 16.3%, 22.6%, 30.8% and 30.3%. While in participants who did not meet the diagnosis, the distribution was 68.9%, 17.2%, 8.4% and 5.4%.



Note. $N = 14465$.

Fig. 1 Item characteristic curves (ICCs) of the PTSD numbing symptoms

Table 1 Difficulty and discrimination parameters of DSM-IV PTSD numbing symptoms from IRT analyses

Item	Difficulty (SE)	Discrimination (SE)
Memory impairment	2.65 (0.13)	0.56 (0.03)
Diminished interest	1.26 (0.02)	2.54 (0.10)
Feeling detachment	1.23 (0.02)	2.92 (0.13)
Numbing of positive emotions	1.33 (0.03)	1.65 (0.05)
Numbing of negative emotions	1.62 (0.06)	0.75 (0.03)
Foreshortened future	2.39 (0.07)	1.43 (0.06)

N = 14,465

The rate of probable PTSD cases was 2.2%, 10.9%, 25.4%, and 34.1% in NoN, NoN, NoP and NoG groups, respectively. Table 2 shows the results of chi-square difference tests for comparing probable PTSD rates in participants with different emotional numbing patterns. When compared with participants who reported no emotional numbing problems, those participants in the NoN group (OR = 5.53), NoP group (OR = 15.41) and NoG group (OR = 23.46) had higher PTSD prevalence. The prevalence of PTSD was higher in the NoG group (OR = 4.25) and NoP group (OR = 2.79) when compared with the NoN group. And prevalence of PTSD was higher in the NoG group than the NoP group (OR = 1.52).

Significant between-group differences in scores of PTSD total symptoms and symptom cluster severity were revealed (see Table 3). Students with emotional numbing symptoms reported higher PTSD symptom scores than those who did not. Numbing of only negative emotions had a small to medium effect on all PTSD symptom cluster scores (Cohen’s *d*: 0.34–0.54). Numbing of only positive emotions had large effects on the scores (Cohen’s *d*: 0.80–1.01), and general emotional numbing had higher effect sizes (Cohen’s *d*: 1.14–1.36).

Functional impairment scores were also significantly higher in children and adolescents who reported emotional numbing problems (Table 4). Participants with numbing of

Table 2 Comparison of the four emotional numbing symptom groups in probable PTSD prevalence

Groups	χ^2 (df)	OR (95%CI)	P
NoP vs. NN	1367.03 (1)	15.41 (12.85–18.48)	<0.001
NoN vs. NN	392.96 (1)	5.53 (4.58–6.66)	<0.001
NoG vs. NN	1916.32 (1)	23.46 (19.45–28.29)	<0.001
NoP vs. NoN	146.27 (1)	2.79 (2.35–3.31)	<0.001
NoG vs. NoN	282.42 (1)	4.25 (3.56–5.06)	<0.001
NoG vs. NoP	23.37 (1)	1.52 (1.28–1.81)	<0.001

NN no emotional numbing group, NoP numbing of only positive emotions group, NoN numbing of only negative emotions group, NoG general numbing of both positive and negative emotions

only negative emotions reported low impairment scores (Cohen’s *d* = 0.32), and participants with numbing of only positive emotions reported intermediate impairment scores (Cohen’s *d* = 0.74); participants with general emotional numbing reported the highest scores (Cohen’s *d* = 0.94). For subdomain functional impairment scores, effect sizes were small in the NoN group (Cohen’s *d* = 0.23–0.31), medium in the NoP group (Cohen’s *d* = 0.57–0.72) and medium to large in the NoG group (Cohen’s *d* = 0.67–0.96). Specifically, impairment scores in all subdomains were higher in participants with general emotional numbing than those with only positive emotional numbing.

The relationships between emotional numbing patterns and overall PTSD symptom/functional impairments were further examined in different age, sex, and ethnicity subgroups (see Supplemental Tables). The results for each subgroup were consistent with findings in the whole sample, and the covariates did not show any moderate effect to the results.

Discussion

This current item-based analysis investigated the role of post-traumatic emotional numbing symptoms in a large-scale child and adolescent sample exposed to a natural disaster. The study performed IRT tests of emotional numbing symptoms, and investigated the association between emotional numbing patterns and probable PTSD diagnosis, PTSD symptom severity, and functional impairments. IRT results showed that numbing of positive emotions demonstrated good item performance, but numbing of negative emotions had poorer performance (indicated by lower discrimination). Group comparison results showed that emotional numbing symptoms significantly increased the risk of meeting a PTSD diagnosis, with greater PTSD symptom severity and functional impairment. In terms of effect sizes, general numbing of both positive and negative emotions had the largest effect sizes. Numbing of only positive emotions had intermediate effect sizes, and numbing of only negative emotions had the smallest effect sizes. These findings reveal the important role of emotional numbing in posttraumatic psychopathology among trauma-exposed youths, from both dichotomous and continuous measurement of PTSD, and contribute to current knowledge on emotion processing in PTSD.

IRT analyses provide important information on the performance of emotional numbing items in relation to other symptoms within the PTSD numbing symptom cluster. This study found numbing of positive emotions had intermediate difficulty and discrimination when compared with other numbing symptoms. This finding means the positive emotion numbing item was frequently endorsed only in patients with moderate and severe PTSD numbing symptoms, and the item has adequate capacity to differentiate individuals with different

Table 3 Group comparison of the four emotional numbing symptom groups in PTSD symptom and functional impairment scores

	Total sample (<i>N</i> = 14,465)	NN (<i>N</i> = 9314)	NoN (<i>N</i> = 2559)	NoP (<i>N</i> = 1498)	NoG (<i>N</i> = 1094)	<i>F</i>	<i>P</i>	<i>P</i> _{correction}
PTSD total score	12.9 (8.7)	10.3 (6.9)	14.3 (8.0)	19.2 (9.1)	23.2 (10.4)	1376.73	<0.001	<0.001
PTSD Criterion B score	3.4 (3.2)	2.6 (2.6)	3.6 (3.2)	5.1 (3.6)	6.5 (4.1)	804.01	<0.001	<0.001
PTSD Criterion C score	4.2 (3.5)	3.2 (2.7)	4.8 (3.2)	6.6 (3.9)	8.1 (4.3)	1192.01	<0.001	<0.001
PTSD Criterion D score	5.3 (3.4)	4.4 (2.9)	5.9 (3.3)	7.4 (3.5)	8.5 (3.7)	889.58	<0.001	<0.001
Overall functioning	21.4 (14.0)	18.6 (12.6)	22.8 (13.6)	28.9 (15.0)	32.1 (16.0)	545.83	<0.001	<0.001
Physical functioning	6.3 (5.5)	5.5 (5.0)	6.7 (5.5)	8.6 (5.9)	9.4 (6.6)	268.10	<0.001	<0.001
Emotional functioning	5.1 (4.2)	4.3 (3.7)	5.5 (4.1)	7.3 (4.6)	8.2 (4.4)	519.13	<0.001	<0.001
Social functioning	4.7 (3.5)	4.1 (3.2)	5.1 (3.4)	6.2 (3.9)	7.2 (4.0)	426.98	<0.001	<0.001
School functioning	5.3 (3.6)	4.7 (3.4)	5.5 (3.6)	6.8 (3.9)	7.4 (4.3)	297.00	<0.001	<0.001

Means with standard deviations in parentheses

*P*_{correction} was calculated after controlling for age, sex, ethnicity and earthquake trauma exposure

NN no emotional numbing group, *NoP* numbing of only positive emotions group, *NoN* numbing of only negative emotions group, *NoG* general numbing of both positive and negative emotions

numbing levels. In comparison to numbing of positive emotions, numbing of negative emotions had comparable difficulty but relatively low discrimination, which means the probability of endorsement is closer in individuals with lower vs. higher numbing levels. Therefore, it would be more difficult to screen individuals with high numbing symptom severity based on this item. Although numbing of negative emotions had a trend of deviation from other symptoms, it performed better than the traumatic amnesia symptom, indicated by lower difficulty and higher discrimination. This result is consistent with previous studies which reported poor item characteristics of the amnesia symptom (Gentes et al. 2014). The strong item performance of numbing of positive emotions indicate it as a good symptom indicator of PTSD assessment, and supports its inclusion in the diagnostic criteria. Despite having a

higher prevalence in our sample, numbing of negative emotions was found to have low discrimination. The results suggest that numbing of negative emotions could be a more common posttraumatic response, but not specific to PTSD (Zoellner et al. 2014). It could be a pathological adaptation which protects children from a distressing experience caused by trauma-related negative emotions (Lansford et al. 2006).

Our study revealed that both types of emotional numbing symptoms were linked to PTSD symptomology. In particular, numbing of positive emotions was more related to probable PTSD diagnosis and PTSD symptom severity when compared with numbing of negative emotions. The results suggest that numbing of positive emotions is more associated with post-traumatic psychopathology than numbing of negative emotions. Although numbing of negative emotions had relatively

Table 4 Post-hoc test of PTSD symptom and functional impairment scores in the four emotional numbing symptom groups

	Pairwise comparison (<i>P</i> < 0.05)	Effect size (Cohen's <i>d</i>)		
		NoN vs. NN	NoP vs. NN	NoG vs. NN
PTSD total score	NN < NoN < NoP < NoG	0.54	1.10	1.46
PTSD Criteria B score	NN < NoN < NoP < NoG	0.34	0.80	1.14
PTSD Criteria C score	NN < NoN < NoP < NoG	0.54	1.01	1.36
PTSD Criteria D score	NN < NoN < NoP < NoG	0.48	0.93	1.23
Overall functioning	NN < NoN < NoP < NoG	0.32	0.74	0.94
Physical functioning	NN < NoN < NoP < NoG	0.23	0.57	0.67
Emotional functioning	NN < NoN < NoP < NoG	0.31	0.72	0.96
Social functioning	NN < NoN < NoP < NoG	0.30	0.59	0.86
School functioning	NN < NoN < NoP < NoG	0.23	0.57	0.70

Post-hoc pairwise comparison *p* corrected by Bonferroni correction

NN no emotional numbing group, *NoP* numbing of only positive emotions group, *NoN* numbing of only negative emotions group, *NoG* general numbing of both positive and negative emotions

small correlations with PTSD diagnosis and symptom levels, it is still noteworthy that general emotional numbing had the highest association with PTSD diagnosis and symptom severity. As previously reported, the role of more general emotional numbing should be noted in children and adolescents as it could be the link between trauma exposure and negative post-traumatic outcomes (Kerig et al. 2016; Kerig et al. 2012). Our study provides further evidence by showing that students with a general numbing of both positive and negative emotions suffered most from PTSD. It is still important to pay adequate attention to general emotional numbing in future studies and clinical practice with trauma exposed children and adolescents. Our findings suggest that we should be more cautious to use the narrowed definition of emotional numbing in DSM-5 when treating young people with PTSD.

Findings from functional impairment comparisons were generally consistent with findings from diagnosis and symptom severity comparisons, which add further support to the functional role of emotional numbing symptoms. It is noteworthy that emotional numbing symptoms were related to both physical and psychosocial functional impairments, but the effect sizes were higher for psychosocial functions. This suggests that previous studies reporting significant associations between emotional numbing and only psychosocial (but not physical) functioning may be due to the lack of statistical power to detect associations between emotional numbing and physical functioning impairment (Pietrzak et al. 2015).

It should be noted that our research was conducted in a young Chinese earthquake survivor sample. The relationship between emotional numbing and PTSD symptomology could be different across different samples. For example, in research of a justice-involved youth sample (Kerig et al. 2016), in which numbing are more likely present in the form of callousness and unemotionality, stronger correlations between numbing of negative emotions and PTSD were reported. In addition, there are some other potential moderators for the relationship between emotional numbing and PTSD. Posttraumatic symptomology is highly variable and deeply dependent on one's cultural context and developmental stage (e.g. McMackin et al. 2012; Nemeroff and Marmar 2018). In our study, we found consistent results across different age groups and ethnic groups. The developmentally and ethnically robust findings yield strong empirical support for the role of emotional numbing symptoms in PTSD, and expand our knowledge regarding child and adolescent posttraumatic responses. However, it is still necessary for further studies to compare results using Eastern vs. Western cultural samples, and child vs. adult samples.

Our current study on PTSD's emotional numbing symptoms has some important theoretical and clinical implications. First, contrary to Litz's model (Litz and Gray 2002), the study

found that the presentation of posttraumatic emotional numbing was not restricted to positive emotions in youths. Additional studies are still needed to generate a theory for the explanation of generalized emotional numbing in PTSD. Studies on neural circuits suggest that salience network underactivity in PTSD patients could lead to inability of experiencing any positive or negative emotions (Lanius et al. 2015). More empirical evidence is still needed. Second, our study could be a reference for future modifications to PTSD diagnostic criteria, especially for children and adolescent criteria. As discussed above, our study provided evidence against the DSM-5 narrowing of emotional numbing symptoms in children and adolescents. For other PTSD diagnostic systems (e.g. International Classification of Diseases, ICD), our study provides support for inclusion of emotional numbing symptom, considering its significant association with functional impairment. Third, the numbing to positive emotions in PTSD overlaps with anhedonia in major depressive disorder (MDD). Our finding of high prevalence and severity of the symptom in PTSD is consistent with evidence of high comorbid MDD rates in individuals with PTSD (Rytwinski et al. 2013). Therefore, our study suggests that assessment and treatment of MDD symptoms might also be warranted when emotion numbing is identified along with other PTSD symptoms in the treatment of young PTSD patients.

Some limitations of the study should also be noted. One main limitation is that this preliminary study was an item-based analysis. The results need to be replicated using better-developed measures of emotional numbing such as the Emotional Numbing and Reactivity Scale (Orsillo et al. 2007). Second, PTSD symptoms and functional impairments were assessed by self-report questionnaires. Future research might include parent and clinical interview data to triangulate and replicate the current findings. Third, the survey was conducted in 2011, and DSM-5 PTSD diagnostic criteria were not yet used at that time. Despite DSM-IV and DSM-5 sharing large overlap in child PTSD diagnosis (Danzi and La Greca 2016), the relationship between emotional numbing and PTSD symptomology still needs to be investigated using DSM-5 criteria. Last but not least, the study was performed 3 years after the earthquake, and other life events during the gap which may affect PTSD symptoms and functioning were not assessed in current study.

To our knowledge, the current study is the first to systematically investigate the psychopathological and functional roles of emotional numbing in child posttraumatic symptomatology. The results revealed associations between different emotional numbing forms, PTSD diagnosis, PTSD symptom severity and posttraumatic functional impairment. Our study provides evidence that regardless of its form, emotional numbing symptoms should gain enough attention in future fundamental and clinical research of children and adolescents' PTSD.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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